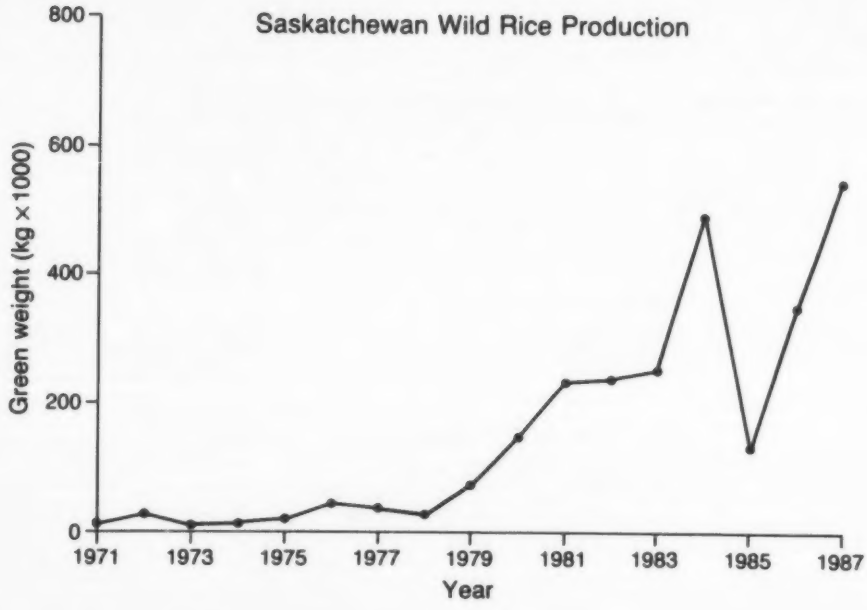
Saskatchewan
Agriculture

Saskatchewan Wild Rice Research 1987



".....You have been blessed with an exciting product. You are in the middle of a development that is historic. .... it will be an extremely valuable, exciting industry and resource for Saskatchewan. For all of Saskatchewan to be proud of. ....."

Honourable Grant Devine
Premier and
Minister of Agriculture

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Research Program (1987) Summary

Year 2 of the 3-year comprehensive research program marked the beginning of more intensive studies on harvester improvement. After numerous consultations with industry leaders, researchers became convinced that increased harvesting efficiency could be achieved through the improvement of the existing "speedhead" principle. The accompanying report prepared by Dr. O.W. Archibold, Crop Science Department, and Prof. W.B. Reed, Agricultural Engineering Department, both from the University of Saskatchewan, shows the different related studies recently undertaken to achieve the desired "harvesting efficiency" improvement.

Encouraging results have been obtained from these studies. Some of these findings are being contemplated for adoption this coming harvest season by some enterprising Saskatchewan growers. These could include a change in the design and positioning of the speedhead, and the use and alignment of the beater bars.

A major revision reflecting design improvements to eliminate or reduce crop loss in addition to further studies on travel speed, power requirements, beater bar and wire mesh modifications among others, will form part of the studies that will be conducted during the coming harvest season.

The study on "The Usefuless of Lake Sediment Analysis as a Measure of Habitat Suitability for Wild Rice" was conducted last year. In the preliminary report submitted by D.C. Painchaud, he suggested that when all other habitat factors are satisfied such as water depth, water clarity, salinity, and plant competition among others, sediment chemistry can aid in determining suitable wild rice growing area. He further mentioned that the most consistent factor is the high "Loss on Ignition" value. Loss-on ignition refers to the measure of organic content of the sediment.

The second year of the study might be able to show much more conclusively the key elements in the sediment for the successful development of wild rice. A parallel study which will include gathering of detailed environmental data and analysis of sediment and water samples at the 9 productive commercial sites, will also be carried out this coming crop year.

Straw decomposition is believed to be one of the major factors of poor crop production. This occurs the year after a good crop, where an estimated 1600 - 5000 kg/ha of straw is left floating as it undergoes decomposition.

As the thick mat of straw remains embedded in the area particularly in spring and up to early summer, it prevents the penetration of sunlight to the bottom of the waterbody where young rice plants are starting to grow. This ultimately results in very poor plant growth and in most cases complete crop failure.

Once the straw is fully decomposed, it becomes the major source of plant nutrients. The need to replenish plant nutrients in the sediment by an organic source is very critical. The use of chemical fertilizer in wild rice farming in Saskatchewan is not permitted.

Dr. O.W. Archibold conducted a number of straw related studies including the effect and efficiency of removing straw, the effect of cutting and mulching straw and the rate of straw decomposition.

The result from the decomposition study shows that only about 60 percent of the straw is decomposed after one year for both the chopped and the unchopped materials.

All these straw related studies are going to be continued in the 1988 season.

A regional annual survey involving 20 different sites across northern Saskatchewan, which began in 1984 for the purpose of evaluating the differences in plant characteristics and productivity, was again conducted during the 1987 crop year. The 1987 survey was expanded to include information on panicle form, seed quality and sediment nutrient levels.

Growth tank trials were also conducted at the University of Saskatchewan using seed collected from the 20 study sites. The growth tank trials did not show significant variation as seen in the field, except a tendency for earlier maturity for seed collected from the eastern sites.

A final report on the 4-year survey will be made at the conclusion of the research program in 1989.

Related studies on market development and promotion, processing and product development, and water control are being carried out under a research agreement managed by the Saskatchewan Wild Rice Council and funded by the Department of Regional Industrial Expansion (DRIE) through its Northern Economic Development Subsidiary Agreement (NEDSA) Program. Growers who are interested in the studies undertaken by the Council should address their inquiries directly to the Saskatchewan Wild Rice Council at Box 1710, La Ronge; Tel: 425-3848.

To assist growers in understanding the research findings of each study, a summary is provided at the end of each report. Growers who want detailed report on any of the studies, are advised to get in touch with the Provincial Wild Rice Specialist:

Pab Orcajada
Provincial Wild Rice Specialist
Soils and Crops Branch
Saskatchewan Agriculture
La Ronge, Saskatchewan
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Wild Rice Harvester Efficiency Studies

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Prof. W.B. Reed - Department of Agricultural Engineering,
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Introduction

With the development of new designs there has been increasing concern over the efficiency of airboat harvesters. Various experiments were conducted during the 1987 field season to determine potential harvest losses with air boats and to evaluate the quality of grain recovered under different operating conditions. The harvester studies focused on the effect of beater bars and speed on harvest yield and grain quality.

Other measurements were made to determine the operational parameters of rice boat harvesters. These included measurement of boat travel speed, engine and propeller performance, boat drag and the effect of wind velocity on boat travel speed.

Results and Discussion

1. Propeller Blast and Losses

Research was carried out in two stages. Initially a grid of measuring points was established at the Air Ronge airstrip and the wind patterns created by three types of airboats were established. Typical results are shown in Figure 1. Maximum wind speeds exceeded 60 mph (100 kph) and speeds over 15 mph (25 kph) were recorded outside the width of the speedhead. Rudder design greatly influenced the displacement of air to the side of the boat during turns.

The second phase of this research investigated seed loss caused by the propeller blast. A La Ronge Industries airboat was positioned in an unharvested stand of rice at Potato Lake and its engine operated at normal r.p.m.'s for a period of 15 seconds. Wind shattered seed was collected in trays set out behind the harvester. Typical patterns of seed loss are shown in Figure 2. Seed losses behind the Rotax 503 powered boat ranged from 8-36 seeds per square meter which represents a loss rate of about 4%. The losses are the percentage of the potential total yield if all kernels develop to maturity. This amount of loss is not typical of loss caused by the propeller air blast because the blast is normally directly behind the boat and is normally directed over the area which has been harvested. Losses will be highest during turns.

2. Loss During Harvest

In addition, collecting trays were set out adjacent to the harvester's course and seed losses during normal harvest operations assessed. Average seed loss patterns for a flat bottomed airboat are shown in Figure 3. These ranged from 47 seed per square meter (5% loss) near the boat hull to 12 seeds/m2 2.5 meters from the boat. A similar rate of seed loss was noted with a pontoon harvester.

The loss occurring beneath the boat hull was not measured because suitable loss measuring equipment has not been developed. The total losses are therefore not known.

3. Beater Bar Project

A comparison of the yield and quality of grain in each compartment of a divided speedhead was carried out at Potato Lake using L.R.I. equipment. One half had no beater bars while the other half had various arrangements of beater bars. The amount of grain harvested during each trial was compared with the control compartment (Figure 4) to establish the comparative efficiency of the the beater bar settings. Grain harvested ranged from 81% to 159% of that collected in the standard table (Figure 5) without bars. The most efficient arrangement was a single bar in the rear position: the least efficient was a single bar mounted in the forward position. Efficiency was generally highest when two bars were used, medium efficiency was obtained with three bars and lower efficiency generally resulted with one bar (except in the rear position).

The single rear mounted bar collected fewer empty hulls than most other settings (Figure 6). The 2-bar rear setting was most efficient in this regard. Average seed weight in the unmodified speedhead recorded during these trials was 42.3 mg. This was greater than the mean seed weight noted in six of the beater bar arrangements. The control seed weight was equaled by the 1-bar rear and 2-bar rear positions and exceeded by the 3-bar rear position in which a mean seed weight of 44.1 mg was recorded. (Figure 7).

These results, although not extensive with regard to various stands of rice, indicate that quantity of rice can be increased without a reduction in mean seed weight (a measure of quality). Also it is quite evident that improper location of the bars could reduce both quantity and quality of rice. The variability of beater bar results is further confirmed in the results obtained using a harvester with a side-mounted table as presented in Figure 10.

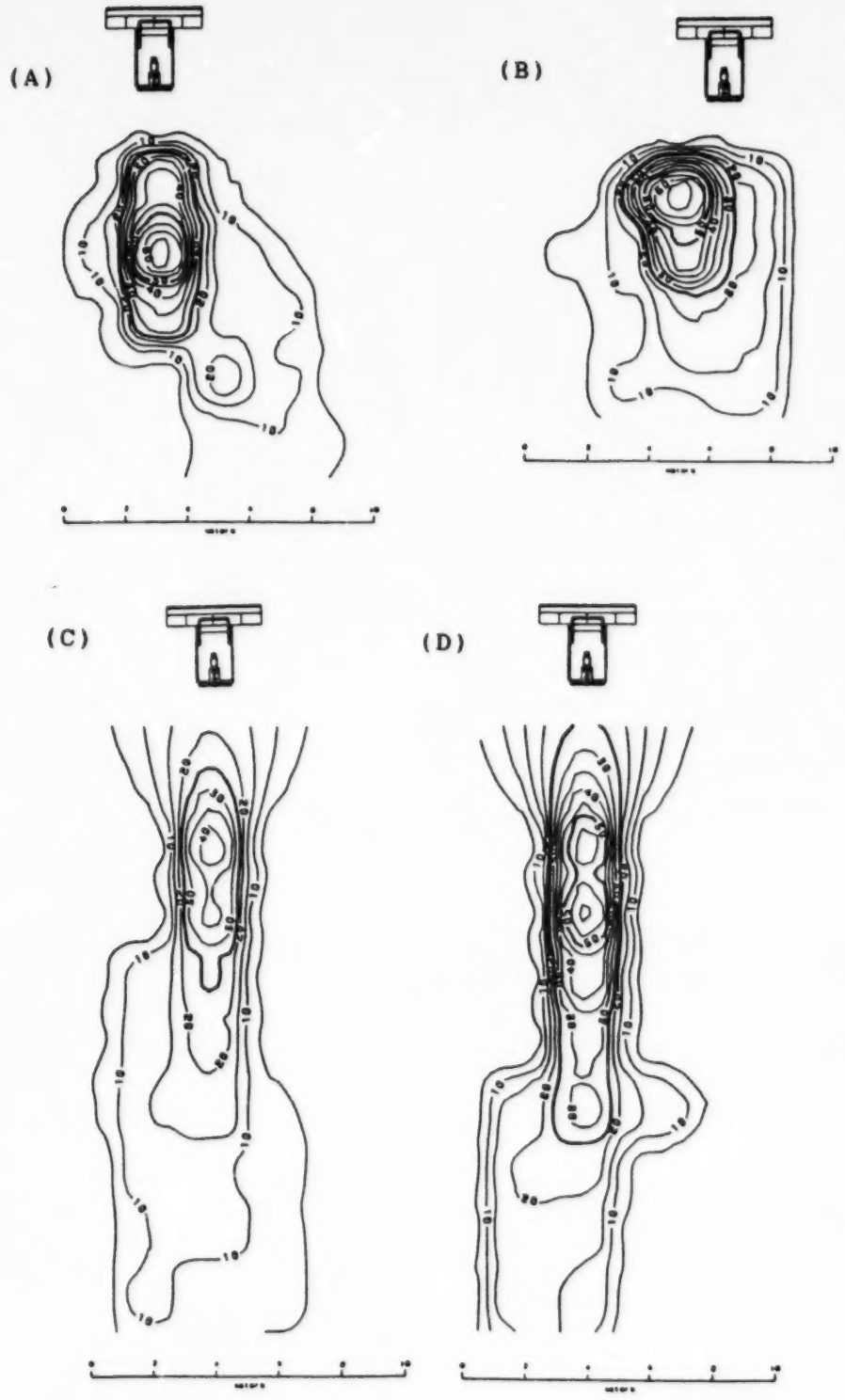


Fig. 1. Wind speed patterns (mph) behind a L.R.I. Rotax 447 boat with straight rudder (A) and 45° left rudder (B). (C) shows Mr. Bill Plunz's 1600 cc Ford airboat operating at 3500 rpm and (D) at 5200 rpm.

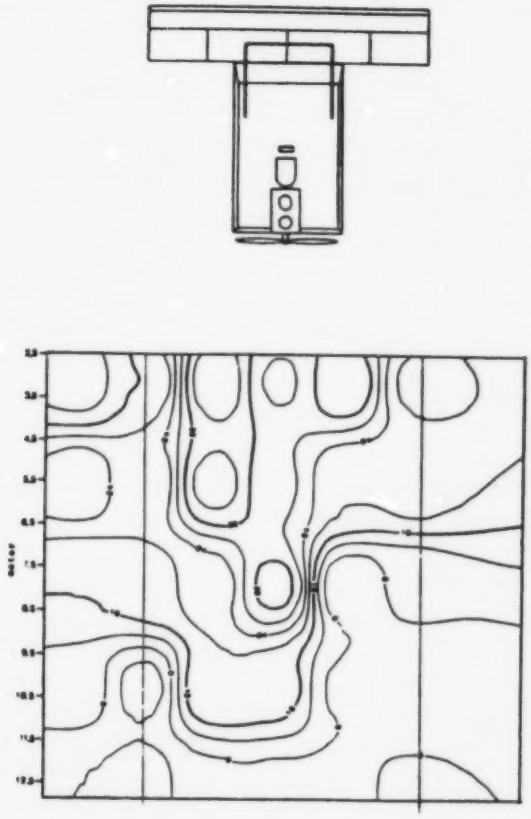


Fig. 2. Seed loss patterns in an unharvested stand from propeller blast (seeds/m²).

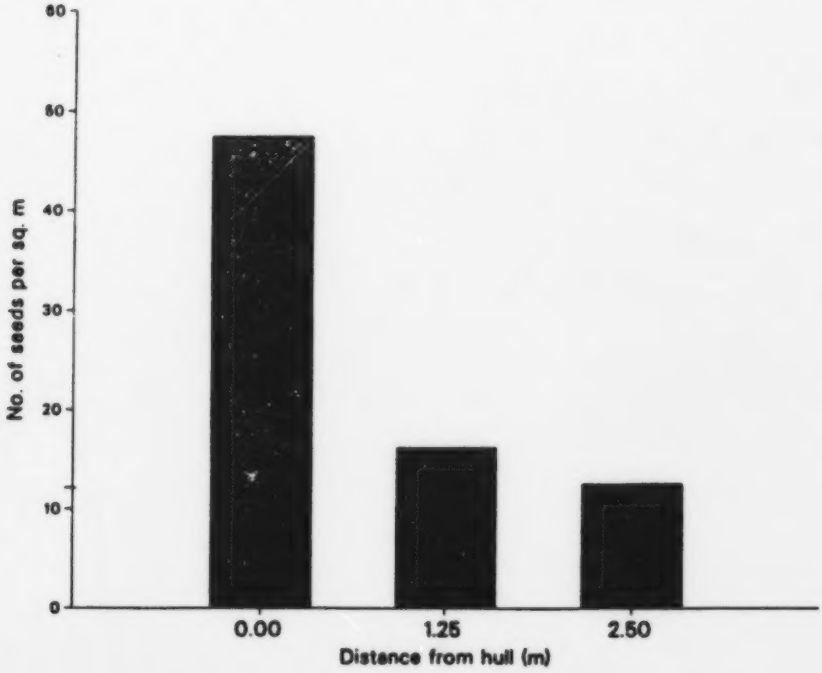


Fig. 3. Average seed loss during harvesting at three distances from the hull of a L.R.I. 503 harvester.

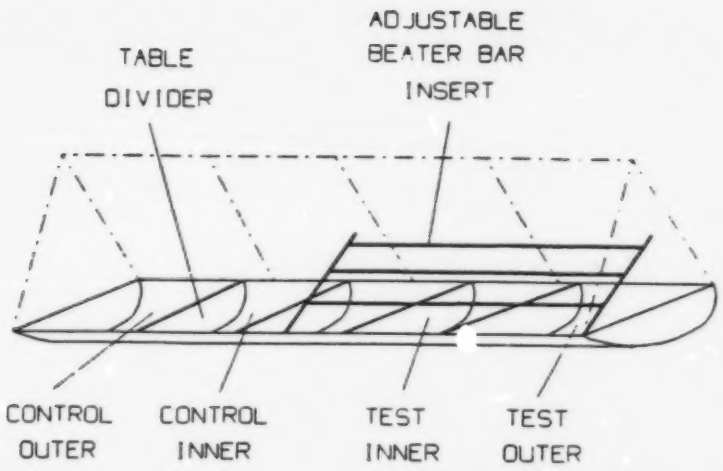


Fig. 4. Schematic diagram of a divided speedhead used in the beater bar studies.

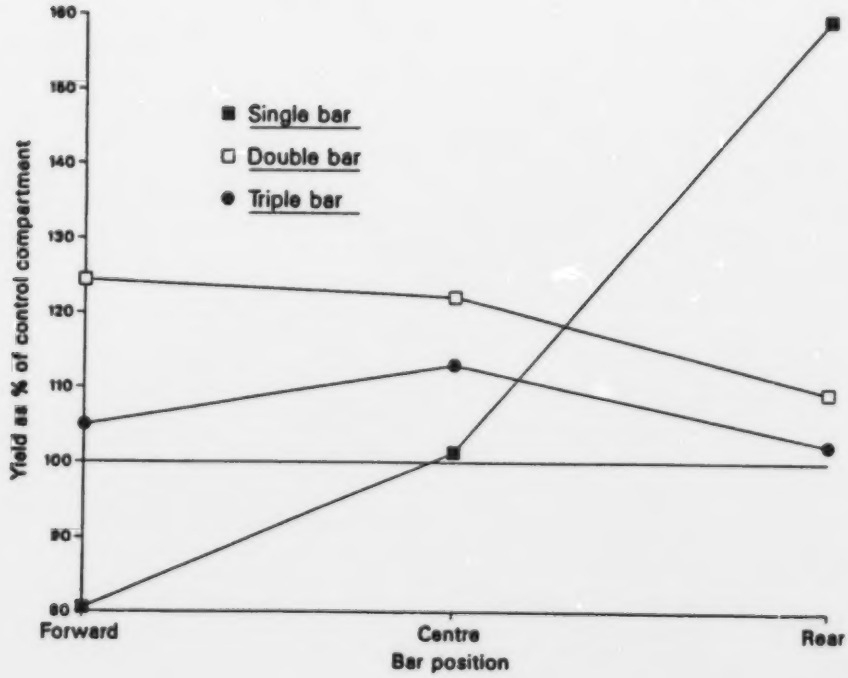


Fig. 5. Comparison of beater bar placement on harvest yields.

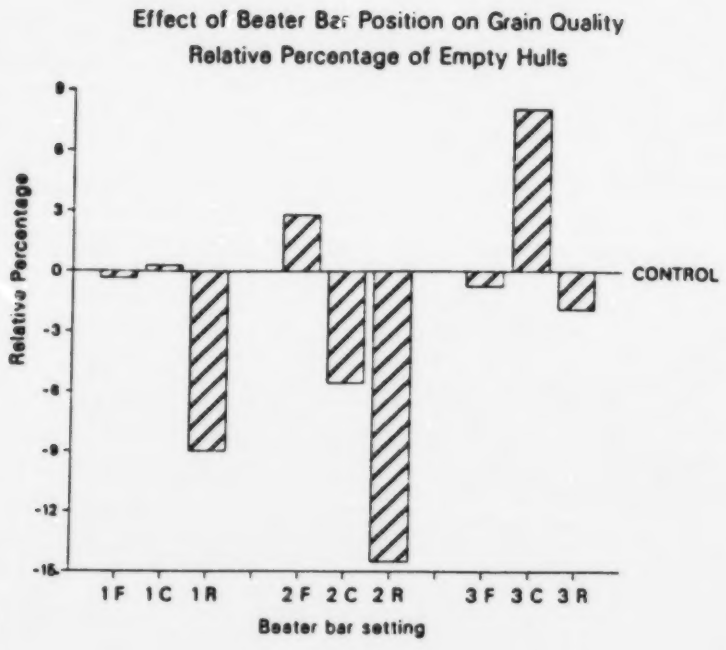


Fig. 6. Effect of beater bar position on percentage of empty hulls collected (1, 2, 3 = number of beater bars, F, C, R = forward, centre and rear position).

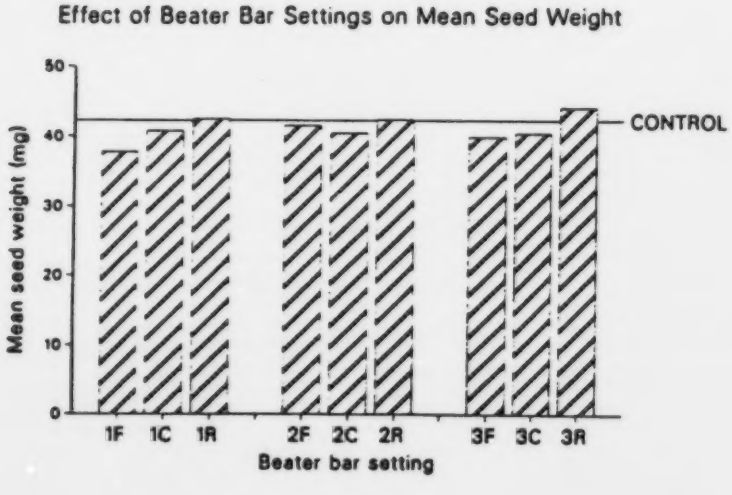


Fig. 7. Effect of beater bar position on average seed weights.

Mr. Doug Horner provided a harvester with the side mounted table to assist videotaping the effect of beater bar arrangements on harvesting. The comparison of grain harvested with the standard front compartment and the modified side table over 15 runs is shown in Figure 12. Bringing the bars to an upright position increased yields. Efficiency tended to decrease as the diameter of the bars increased. Efficiency tended to increase as the number of bars increased.

It must be noted that the results of Figure 10 are not directly comparable to the divided speedhead results because the control, a standard speedhead, was equipped with one beater bar. The crop stand was quite different and in a different lake. In addition the side-mounted header was at a fixed height and may not have always been at the optimum height.

4. Boat Speed Trials

Tests to determine the effect of travel speed on grain yield and quality were conducted at Morning Lake using Mr. Gary Kidd's modified pontoon harvester. Four passes were made through the wild rice. The two slower passes were made at 10.0 and 10.5 mph and the two faster passes at 13.5 and 14.0 mph. Increasing speed from 10.5 and 13.5 mph resulted in a 57% increase in grain harvested in a good stand, but in a poor stand a speed increase from 10 to 14 mph increased the amount harvested by only 1.3%. The percentage of empty hulls ranged from 8.4% at 10.5 mph to 23.4% at 14.0mph (Figure 8). Further, the mean weight of the grain declined with speed. At the slower speeds average seed weight as 46.8 mg compared to 41.4 mg during the faster runs (Figure 9).

Effect of Wind on Travel Speed

Wind direction had a large effect on the boat travel speed. Speed reduction ranged from 25% to 32% when travelling into moderate winds of 4 to 10 mph as compared to travelling with the wind. Covering the screened back of the speedhead caused speed reductions ranging from 37% to 48%. See Figure 10 for speeds measured at a constant engine speed with a La Ronge Industries fibreglass boat and see Figure 11 for speeds measured with a pontoon harvester.

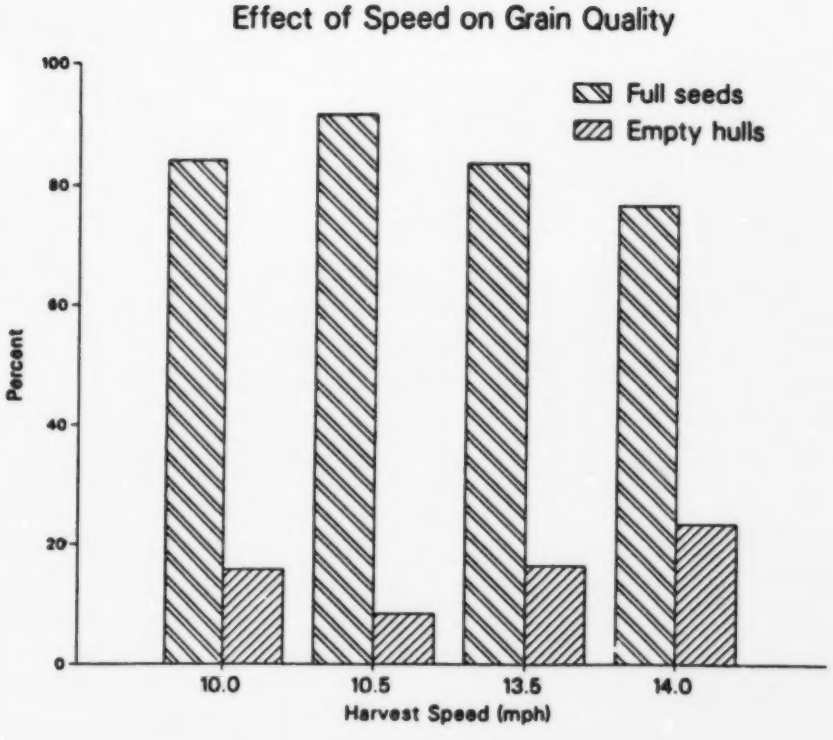


Fig. 8. Effect of harvest speed on grain quality.

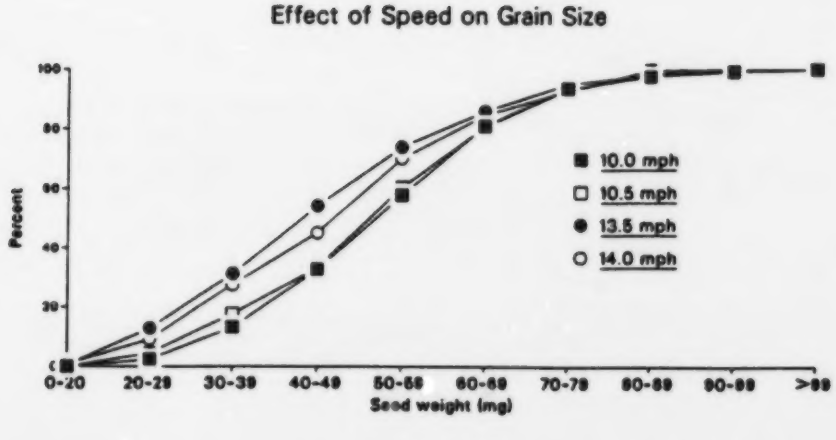
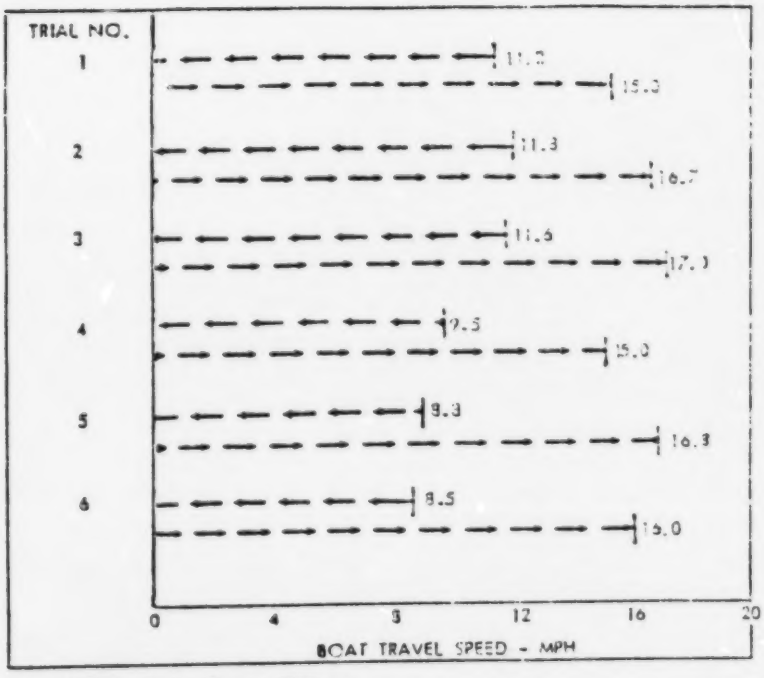


Fig. 9. Effect of harvest speed on grain size.

EFFECT OF WIND ON TRAVEL SPEED

LRI FIBREGLASS BOAT

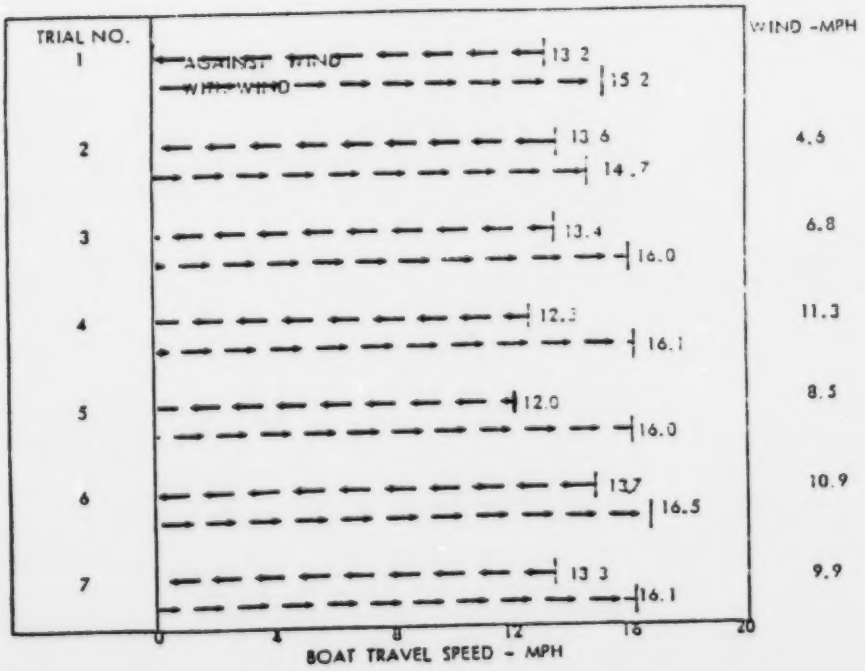


NOTE - Engine Speed - 5000 rpm.
Trials 4,5 & 6 - the speedhead screen was covered

Figure 10

EFFECT OF WIND ON TRAVEL SPEED

PONTOON HARVESTER



NOTE: Engine Speed - 3800 rpm for all trials
Trial No. 4 - Speedhead removed from boat
Trials No. 5,6&7 - Without speedhead, but an equal weight added

Figure 11

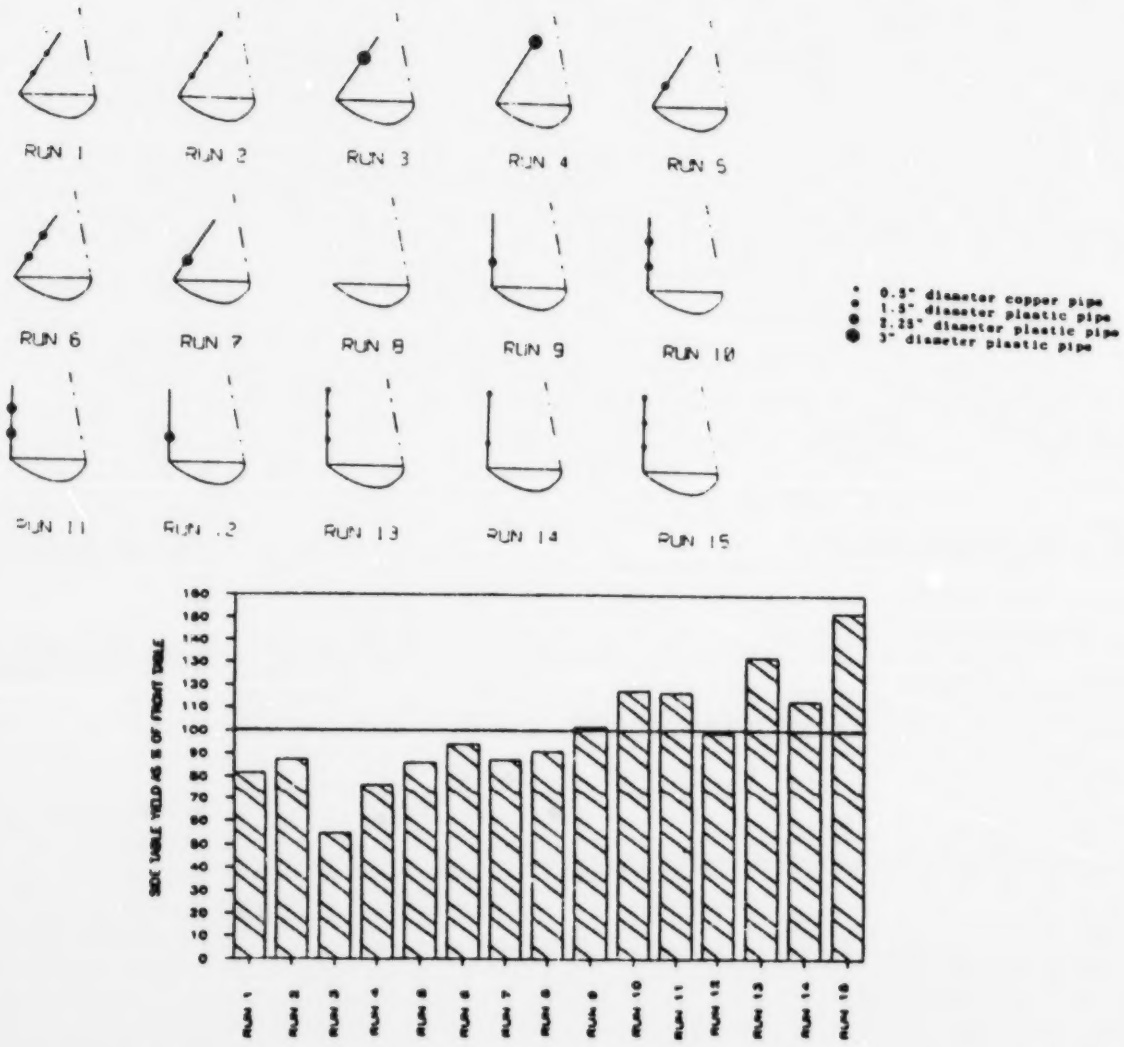


Fig. 12. Arrangement of beater bars and efficiency ratings recorded with a side mounted table. (Note the cameraman was not on board during run 15 - speed was increased by about 2 mph resulting in 20% higher yield than run 13.

Travel Speed During Harvest

A typical boat travel speed was about 14 mph, but large variations are caused by the wind and by the drag of the crop on the speedhead. Travel speed measurement devices are not used on rice harvesters. Although speed trials were conducted to measure the effect of harvesting, the effect on total yield (sum of the total number of passes) was not determined. It was apparent that height speeds cause crop damage which could reduce the potential yield.

Travel Speed Measurement

A Dickey-John speed indicator which utilized a radar device was obtained from the manufacturer and found to be suitable for measuring boat travel speed. Calibration was necessary along with proper mounting on the boat. Although costly, it was essential for conducting research trials.

A paddle wheel speed indicator was also tried but proven to be unsatisfactory. Further development is necessary to obtain a low cost boat speed indicator. Travel speed appears to be important in the efficient harvesting of wild rice although the optimum speed has not been established.

Summary

a. Wind speed patterns behind airboats vary with design. Maximum wind speeds may exceed 60 mph (100 kph).

b. With Rotax powered boats, high wind speeds may occur beyond the ends of the table. With bigger engines the zone of high wind velocity was concentrated within the width of the speedhead.

c. Losses from propeller blast behind a Rotax powered boat ranged from 8 to 36 seeds m-2 (4% average loss rate) in an unharvested stand. This could be important during turns, but the major area of high wind velocity occurs directly behind the boat where the rice has been harvested.

d. Losses during harvesting vary with distance from the boat. Close to the hull, seed loss could be as high as 5% decreasing to 1.2%, 2.5 m from the hull. Losses in the path of the boat hull were not measured.

e. For pontoon harvesters, a similar pattern of seed loss with distance from the pontoons was noted.

f. Grain harvested with a speedhead fitted with differing arrangements of beater bars averaged from 81% (1-bar front) to 159% (1-bar rear) of the grain harvested with a standard table without bars. Efficiency was generally highest with a two bar arrangement.

g. The number of empty hulls decreased noticably when two bars were mounted in the central position.

h. Mean seed weights were generally reduced when beater bars were fitted.

i. Trials conducted with a side mounted table suggested that bringing the bars to an upright position increased the amount harvested. Efficiency tended to decrease as the diameter of the bars increased. Efficiency tended to increase as the number of bars increased.

j. As boat travel speed increased the quantity of grain collected increased. At Morning Lake, the amount collected in a single pass increased 57% when travel speed increased from 10.5 to 13.5 mph. At Montreal River, increasing speed from 8.5 to 10.5 mph increased the amount harvested by 23%. The increase is independent on stand quality.

k. As travel speed increased the percentage of empty hulls increased.

l. Mean seed weight declined as harvest speed increased.

The Usefulness of Lake Sediment Analysis as a Measure of Habitat Suitability for Wild Rice

D. L. Painchaud - Department of Crop Science
University of Saskatchewan

Introduction

In 1987, a project was designed to examine various relationships between wild rice growth and sediment chemistry. The main emphasis of the study was to compare established wild rice stands with habitats not capable to supporting wild rice. The objectives of the two year project were to determine:

a. Why previously seeded sediments, where plant competition and water depth are not limiting factors, will not support wild rice.
b. What sediment characteristics produce the greatest wild rice yields.
c. If tissue analysis provides an insight towards the fertility of the sediment.
d. What sediment characteristics are most important when testing for potential wild rice sites.

Initially the study was to include four sites on Kazan Lake. Of the four sites only Shaw Bay was a commercially viable stand, Kazan River was a marginal stand, and both Birch Creek and Walton Bay were poor sites. Unfortunately, the seeding history of the latter three sites and the lack of water clarity at Walton Bay precluded the correlation of wild rice productivity to sediment chemistry. The three sites were seeded in the fall of 1987 in preparation for the following year's study.

Three good sites and two poor sites, whose production differences could be attributed primarily to sediment chemistry, were added to the study. The three commercially viable stands included were Joe's Lake, Jarvis Lake and the southwest site on Mikinac Lake. The poor sites, both seeded in the falls of 1984 and 1985, are located at the southeast end of Mikinac Lake and the northwest end of Turtle Lake. Neither currently possess any wild rice although the Turtle Lake site did support a marginal stand in 1984. Joe's and Jarvis Lakes are located twenty-five miles northeast of Meadow Lake. Mikinac Lake and Turtle Lake are situated thirty miles southwest of Meadow Lake.

Data were also collected at Torch and Clearsand Lakes, two newly seeded sites northeast of Prince Albert.

Sediment and water samples were taken at 4 times during the growing season. In addition, water depth, water temperature, water pH and water conductivity were measured in the field. Wild rice plants were collected, separated into leaves, stems and roots, and transported to the laboratory for tissue analysis. At the end of the growing season mature plants were collected, dried and various morphological characteristics were assessed. Table 1 lists the variables collected.

Stand Characteristics of Productive Sites

Plant characteristics of the four productive sites are shown in Table 2. The variation in plant density may be explained, in part, by the recent histories of the four sites. Joe s Lake, which possesses the highest plant density, has experienced high yields in the previous two years. Due to inefficiencies of current harvesting practices large quantities of wild rice seed have been deposited back into the lake resulting in a thick volunteer crop. However, competition has led to a decrease in vegetative production and number of tillers.

Jarvis Lake, which suffered flooding conditions in July of 1986, lost up to one half of the crop. The areas which were badly damaged were reseeded in the fall of 1986. Plant densities in 1987 were half that of Joe's Lake but the vegetative growth was greater due to increased tiller numbers, plant size, and stem weight.

The newly seeded Mikinac west site had plant densities similar to those at Jarvis Lake yet the plants, and the number of tillers, were larger.

Stand density in the northwest part of Shaw Bay was the least of all sites at 30 plants m-2. Plants growing in this vicinity most likely originated from a light scattering of volunteer seed. Profuse tillering was characteristic of this site.

The differences in stem lengths are related to water depth. Plants growing in deeper water (Table 3) attain the greatest heights (Table 2). The depths listed for Joe's Lake are misleading in that the rice plants grew from a mat of decomposing wild rice thatch suspended 35 cm beneath the water's surface.

Sediment Properties

1. Loss on Ignition

   Variation in sediment chemistry within and among sites was great (Figure 1), however, a couple of trends did emerge. The most productive sites have the highest loss on ignition (L.O.I.) values (Figure 2). L.O.I. measures the percent organic matter in the sediment. The breakdown of the organic matter is an important nutrient source for wild rice plants.

2. Nitrogen

Dry plant material normally contains between one and five percent by weight nitrogen. In dry land agriculture, crop responses to nitrogen additions are greater than for any other nutrient application indicating that it is the limiting nutrient in plant growth.

In the submersed sediments there is a natural accumulation of nitrogen throughout the growing season as a result of biological fixation which should supply ample nitrogen for wild rice growth.

3. Phosphorus

Phosphorus occurs in most plants in concentrations between 0.1 and 0.4 percent.

In contrast to nitrogen the natural supply of phosphorus is nearly entirely dependent on the weathering of P-bearing minerals and the decomposition of organic matter. Typical wild rice sediments are composed primarily of organic matter with only small quantities of P-bearing minerals hence, most of the available phosphorus is derived from the breakdown of organic matter. The form of available phosphorus is pH dependent.

Wild rice productivity is thought to be limited by inadequate levels of phosphorus. The increase in tillering of the Mikinac Lake plants compared to the Jarvis Lake plants (Table 1) may, in part, be due to the higher levels of phosphorus present in the sediments (Figure 3). However, as the majority of phosphorus is supplied through organic turnover an accurate measurement of available phosphorus cannot be gained through a normal sediment analysis.

Plot trials were conducted in Saskatoon using soils of varying nutrient content. As these soils were higher in mineral content and lower in percent organic matter a soil analysis more accurately described the soil's nutrient availability. Wild rice productivity (Table 4) was highest in the soils possessing the most phosphorus (Figure 4).

It may be possible, through soil aeration, to trap phosphate in the sediment making it available for plant uptake. The oxygenated layer in bottom muds regulates the nutrient cycles in lakes. It acts as a sink for phosphate and other plant nutrients. If the oxygenated layer disappears large amounts of phosphate are released from the sediment into the water.

4. Micronutrients

Micronutrient availability, like phosphorus, is dependent on the weathering of minerals and the decomposition of organic matter. As their requirement is small the minute levels available are usually sufficient for wild rice growth. However, the Mikinac Lake site shows signs of a possible copper deficiency. The last two sediment samples contained no measurable copper (Figure 5). The stem immediately preceding the panicle on many of the tillers was spindly, bent and/or broken. Copper is essential in stem development.

Copper deficiency is well known in a number of different crop plants including oats. In extreme cases panicle formation and seed set is absent.

Sediment Chemistry of Poor Sites

The poor east site on Mikinac Lake was located 75 m from the most southerly point of the productive west site. Almost no wild rice seed has ever germinated at the east site which is characterized by a total absence of water plants. A comparison of the sediments of the east and west sites revealed similar quantities of all nutrients except iron. As depicted in Figure 6 the iron content of the east site sediment was extremely low. Iron is important as a buffer against the reduction processes which occur in submersed soils. Sediments devoid of iron progress to a second stage of reduction with a build up of toxic products such as hydrogen and methane. Plants cannot survive in such an environment.

The Turtle Lake site, during the 1984 growing season, supported a patchy, marginal wild rice stand. An analysis of its sediment indicated a patchy distribution of iron. Where iron is present in sufficient quantities, the reduction process is halted, and wild rice may be able to become established.

Tissue Analysis

The purpose of the tissue analysis in this study was to correlate nutrient uptake with nutrient availability. Figure 7 illustrates the uptake of N, P, and K at three sites on Kazan Lake. For most plants, young tissues have higher N, P, and K contents than old tissues. Nutrient uptake at the three sites was similar. However, as seen in Figure 1, the concentration of N, P, and K in the sediment at each site varied greatly indicating a poor relationship between nutrient uptake and extractable nutrient content in the sediment.

Torch and Clearsand Lakes

A complete nutrient analysis of the sediment from the two lakes was performed. N, P, and K contents were quite similar as shown in Figure 8. Only the iron concentration differed between sites averaging 0.06 g m-2 at Clearsand Lake and 13 g m-2 at Torch Lake. Both lakes were seeded in the fall of 1986 but only the wild rice at Clearsand Lake survived to maturity.

Torch Lake is characterized by a lack of weed growth. Clearsand supports abundant growth of Chara, a plant-like algae. It appears that some environmental factor, other than sediment chemistry, is prohibiting the colonization of the Torch Lake sediments. A chemical analysis of the water may reveal some limiting characteristic, perhaps high sulphate levels are preventing wild rice growth.

Summary

Provided all other indications are positive (proper water depth, water clarity, salinity, plant competition, etc.) sediment chemistry can aid in the determination of suitable wild rice habitat. Perhaps the most consistent trait of good rice habitats are high L.O.I. values. As nitrogen is naturally supplied in sediments through biological fixation, sediments possessing high phosphorus levels should produce the best wild rice yields. Sediments high in nitrogen and phosphorus may induce micronutrient deficiencies due to increased plant growth, although, in most sediments, this will not be a problem. Iron deficiencies may accelerate reduction processes in submerged sediments causing a build-up of toxic reduction products such as hydrogen and methane. Tissue analysis did not correlate well with the extractable nutrient concentrations present in the sediment casting some doubt on its usefulness as a measurement of sediment nutrition. The inclusion of Torch and Clearsand Lakes emphasizes the concern that many factors, other than sediment chemistry, are important in characterizing wild rice habitats.

TABLE 1. Sampling variables in the field sampling and lab analysis.

Environmental Characteristics:	water depth, water temperature
Plant Population:	stems/m^2, tiller no., stem length, productivity g/m^2, biomass g/plant
Sediment Chemistry:	pH, conductivity, ammonium, phosphate, calcium, magnesium Potassium, sodium, iron, zinc, copper, manganese
Water Chemistry:	Total dissolved solids pH, conductivity, sodium, calcium, magnesium, potassium, chloride, sulphate, bicarbonate

TABLE 2. Wild Rice Population Characteristics.

Site	Number of stems (m^2)	Tiller Number ($plant^{-1}$)	Density ($plant\ m^{-2}$)	Plant Weight (g)	Productivity (gm^{-2})	Stem Length (cm)
Shaw Bay	77	2.6	29.6	16.5	489	190
Joe's	131	0	131	4.0	525	133
Jarvis	102	.7	69	9.7	673	191
Mik. w.	122	1.8	69	-	-	200

TABLE 3. Seasonal Water Depth.

Plant Stage	Lake Depth (cm) Mik. W.	Joe's	Jarvis	Shaw Bay
pre-emergent	--	--	--	90
floating leaf	80	55	72	90
aerial leaf	78	55	76	76
flowering	80	70	101	--
mature	--	70	--	45

TABLE 4. Field Lab plant Characteristics.

	Stem length (cm)	Number of Tillers (plant^{-1})	Stem Weight (g)	Number of Seeds (main stem)
Soil	115.0	1.38	N/A	42.9
Soil & Peat	125.2	.49	4.71	59.4

Fig. 1.

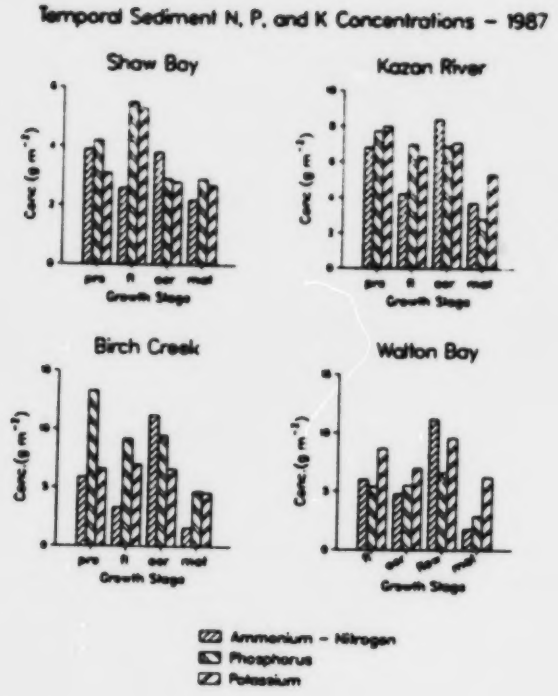


Fig. 2.

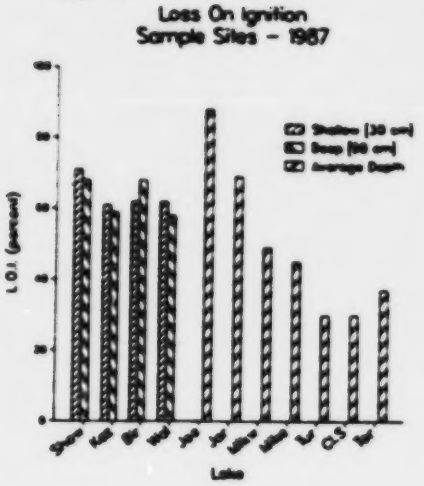


Fig. 3.

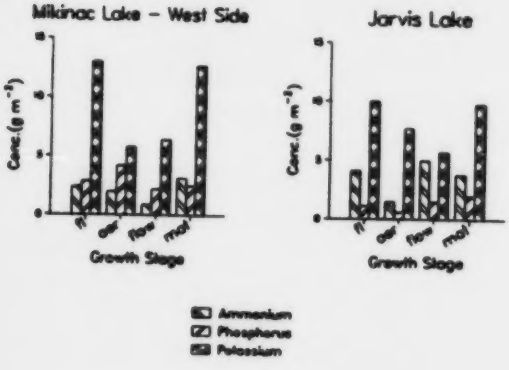


Fig. 4.

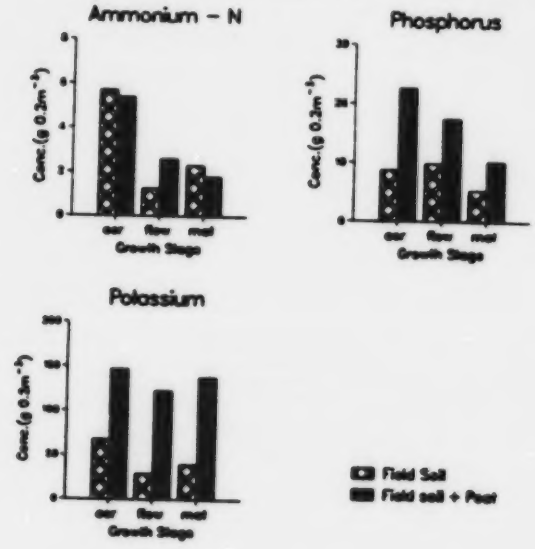


Fig. 6.

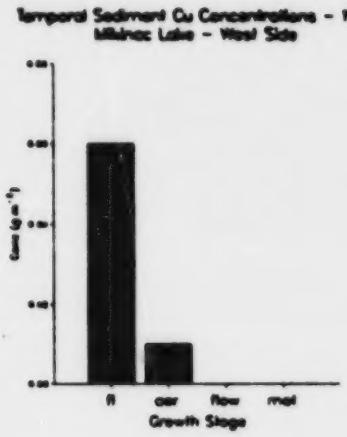


Fig. 6.

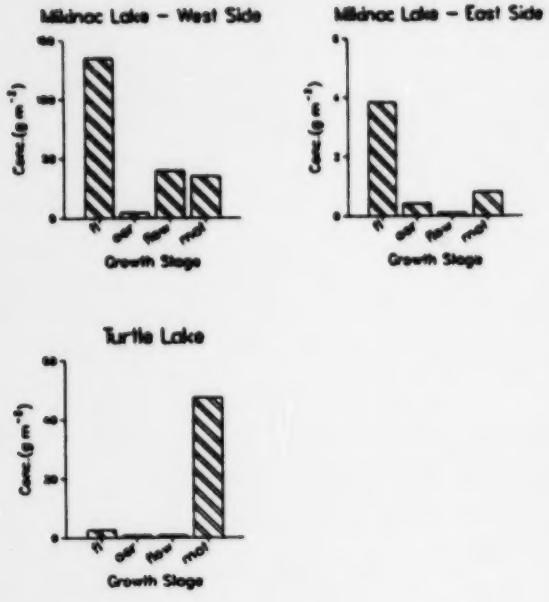


Fig. 7.

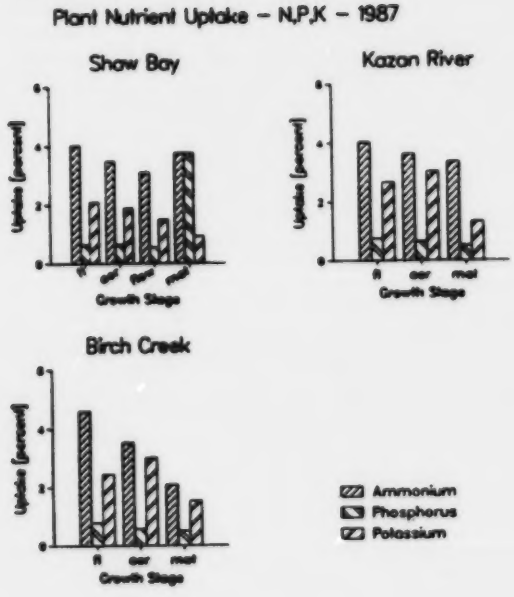
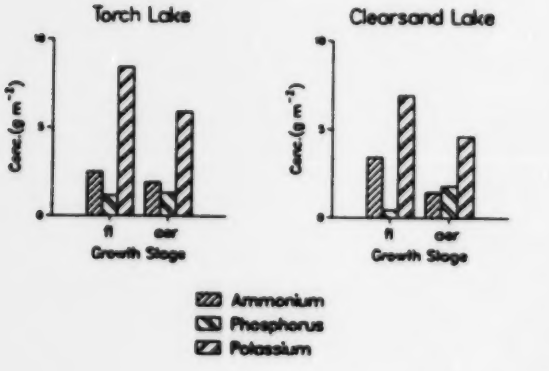


Fig. 8.



Wild Rice Straw Removal and Decomposition

O. W. Archibold, Department of Crop Science
University of Saskatchewan

A considerable amount of straw can be produced in a stand of wild rice during the growing season. If the straw persists as a floating mat into the spring it might shade out new seedlings. If it sinks during the winter seeds on the lake bed might be smothered. However, the removal of straw from a lake could lead to a depletion of nutrients and decreased productivity. Straw production in 20 sites across Saskatchewan for the period 1984-1987 is shown in Figure 1. Excessive straw residues has been suggested as a factor in the cyclical pattern of grain production noted in unmanaged wild rice stands (Figure 2). Three straw related projects were undertaken in 1987. These included the use of a straw removal barge, a straw mulching experiment and a study of straw decomposition.

1. Straw Removal Project

This project has a two fold objective. The suitability of a weed harvester (Figure 3) for straw removal was assessed together with the effect of clearing on crop production. Part of Mr. Vital Morin's patch near Ile a la Crosse was cleared in the spring of 1987. Most of the straw at the time the study commenced had already been flattened into mats or had sunk to the bottom. Typically, it took about 30-35 minutes to load up the barge and about 10 minutes to empty. A second clearing operation was carried out after harvest when the straw was still standing. The barge could be loaded in about 10 minutes but the straw was more bulky and unloading took 10-30 minutes. The fall clearing operation however, was less time consuming and a greater volume of straw was removed.

The effect of clearing on stand density, tillering, and seed production is shown in Figure 4. By the end of the growing season, a 43% increase in stand density was noted in the cleared area., but fewer plants had developed tillers. Seed production averaged 32.4 seeds/stem in the cleared area compared to 44.8 seeds/stem in the uncleared patch. Clearing increased potential grain yield from 1208 kg/ha to 1251 kg/ha and straw production was also increased from 1752 to 2746 kg/ha (Figure 5).

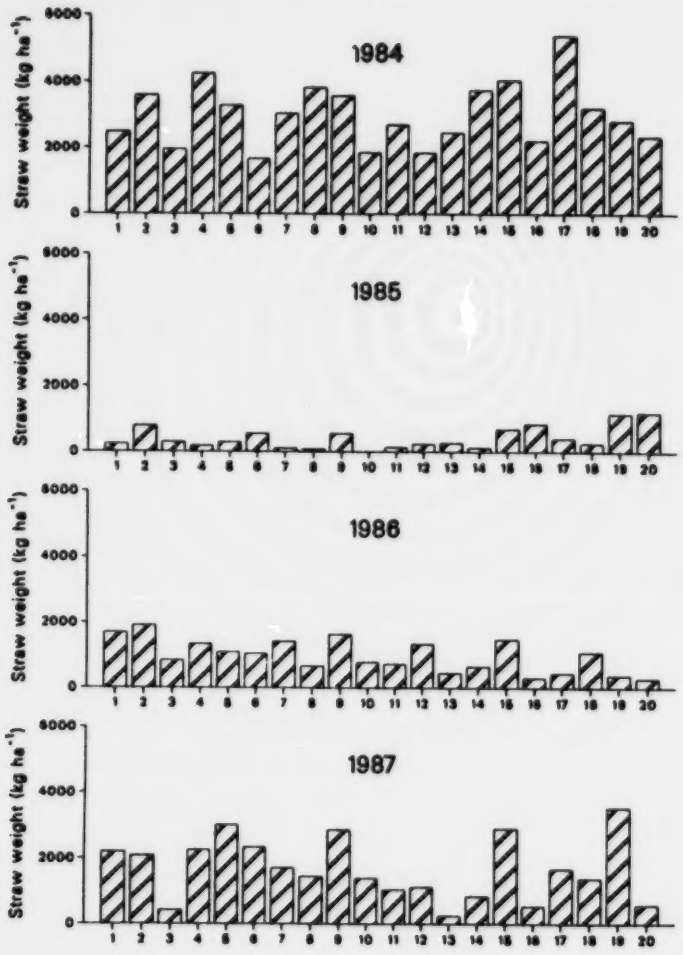


Fig. 1. Annual straw production for 20 sites across Saskatchewan for the period 1984-1987.

Fig. 2. Wild rice production in Saskatchewan, Manitoba and Ontario (1970-1987).

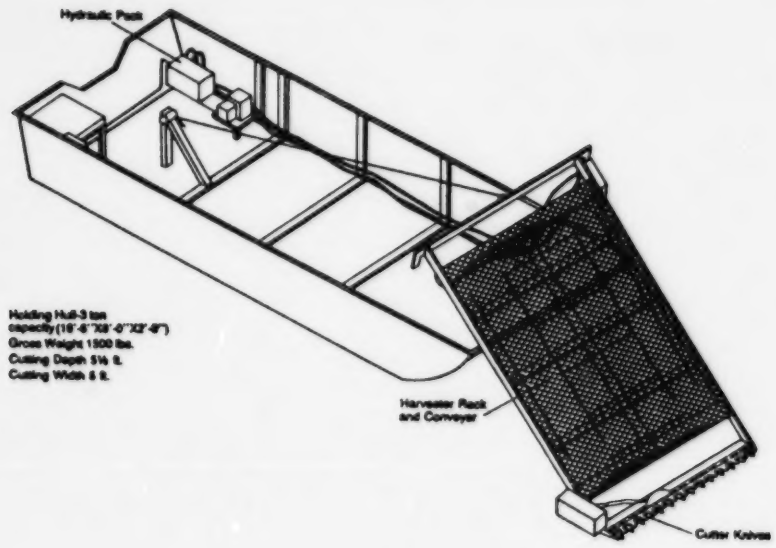


Fig. 3. Schematic drawing of the aquatic weed harvester used in the straw removal project.

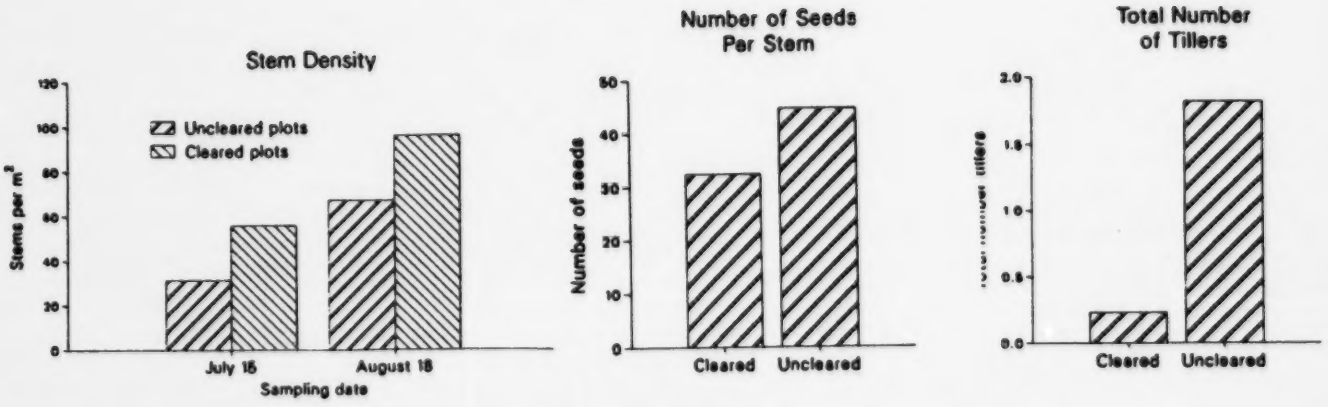


Fig. 4. The effect of straw clearing on stand density, tiller production and seed production per stem.

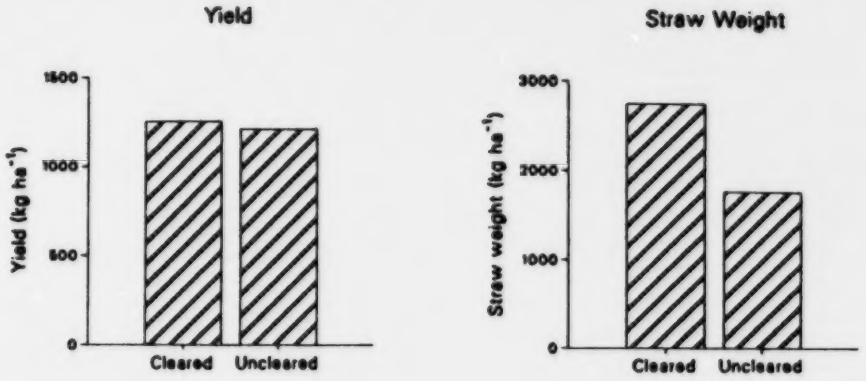


Fig. 5. The effect of straw removal on potential grain production and straw production.

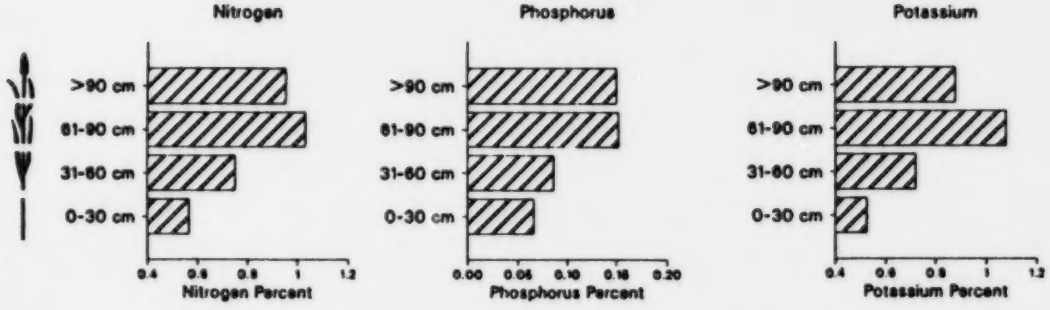


Fig. 6. Distribution of nitrogen, phosphorus and potassium in wild rice plants.

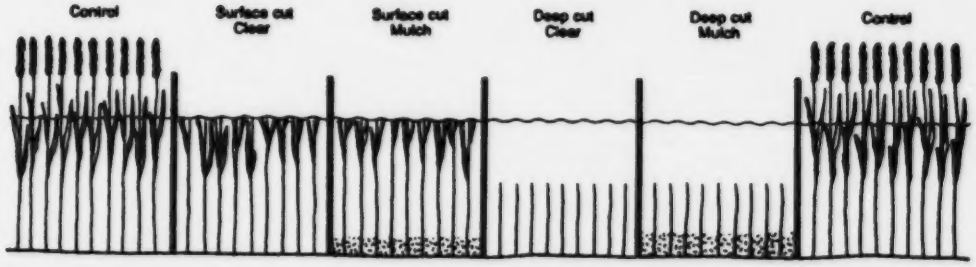


Fig. 7. The four straw treatments used in the thatch study at Mercer River.

Studies in Ontario have estimated the average nutrient content of straw at 130 kg ha-1 nitrogen, 4 kg ha-1 phosphorus and 29 kg ha-1 potassium. Chemical analysis of the plants showed that these nutrients are somewhat more concentrated in the upper parts of the plant (Figure 6), the parts that are most easily removed. The plants in this study averaged 140 cm in length. Cutting them at 90 cm above the lake bed would remove 23% of stored nitrogen, 27% of stored phosphorus and 22% of stored potassium: a 60 cm cutting height would remove 54% stored potassium. If these nutrients are not returned to the lake, deficiencies could arise similar to those reported in some Ontario lakes.

2. Straw Clearing and Mulching

This study was designed to evaluate the effect of cutting depth and mulching on subsequent crop development. Four straw treatments were used. The first consisted of cutting standing straw at the lake surface and removing the residue. In the second, the straw was cut at the surface then mulched and returned to the plot. Treatments three and four were similar except that the cutting depth was 30 cm below the water surface (Figure 7). The effect on grain yield is shown in Figure 8. Potential seed yield for the treatments ranged from 1545 to 1989 kg ha-1 compared to 1535 kg ha-1 for the control plot. The highest grain yields resulted from the deep cutting and mulching treatment. Straw production in the control plot averaged 3999 kg ha-1 (Figure 9). This compares to a range of 3912 to 4960 kg ha-1 for the various treatments with the deep cut, mulch treatment again resulting in the highest production.

The results of this study suggest that some form of straw treatment would benefit stand productivity. Since the deep cut, mulch plots were the most productive it would appear that a process which reduces straw bulk while retaining its nutrients could be most beneficial. However, as well as improving grain yields, increased straw production may be expected. Once started, straw management may need to be continued to maintain crop yields. Straw treatment is a time consuming and laborious task. Based on current returns, it appears to be unjustified as an annual stand management practise, but could benefit sites in which thick mats of straw accumulate annually.

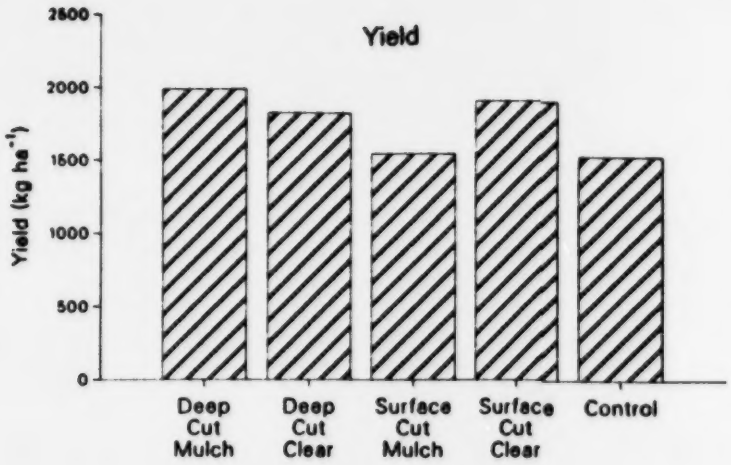


Fig. 8. The effect of cutting and mulching treatments on grain yield.

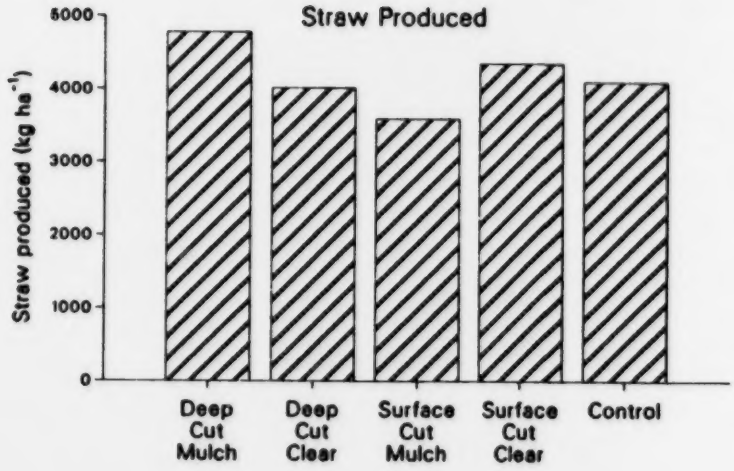


Fig. 9. The effect of cutting and mulching treatments on straw production.

3. Straw Decomposition

Straw decomposition samples consisting of shredded and unshredded wild rice plants were submerged in Demchenko Lake in October 1986. The bags have been retrieved at 3 month intervals for weight loss determination and chemical analysis. During the first 12 months about 60% of the straw had been broken down (Figure 10). Shredded straw decomposed at a slightly faster rate than unshredded material. Little difference occurred in rates of nutrient release between treatments (Figure 11). Phosphorus was retained a little longer in the shredded material, but nitrogen and potassium levels were almost identical.

Summary

a. Straw production fluctuates noticeably between years. In the short term this could affect annual grain yields through smothering seedlings; in the long term the balance of nutrients in the lake may be affected.

b. Straw removal by aquatic harvester takes about 30 minutes per load. It is more efficient to remove straw in the fall while it is still standing.

c. Straw removal tends to increase grain production, but the increase is too slight to justify cost of operation.

d. Straw removal increased plant biomass in the subsequent growing season. This could lead to bigger straw problems in later years.

e. A greater proportion of nutrients is found in the upper portion of the plants. This is the part most easily removed when standing straw is cut.

f. Mulching of straw may be needed to return nutrients to the ecosystem if continued straw management is to be successful.

g. Study plots in which deep cutting and mulching operations were conducted were more productive than untreated plots. Deep cutting with no mulching also improved yields.

h. Decomposition rates and the release of nutrients was similar in shredded and unshredded straw.

i. Mulching could reduce the physical mass of straw resulting in increased germination and less suppression of young plants.

j. Straw treatment may be beneficial in sites in which thick mats of straw have drifted into a site, but it is a time-consuming and laborious process. Based on current economic returns it appears to be unjustified as an annual stand management practise designed to increase yields.

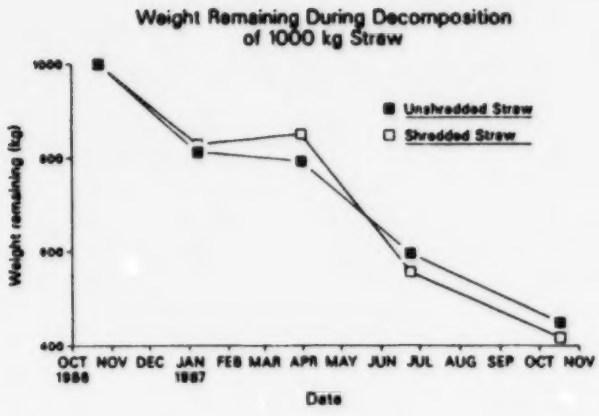


Fig. 10. Straw decomposition rates for the period October 1986 to October 1987.

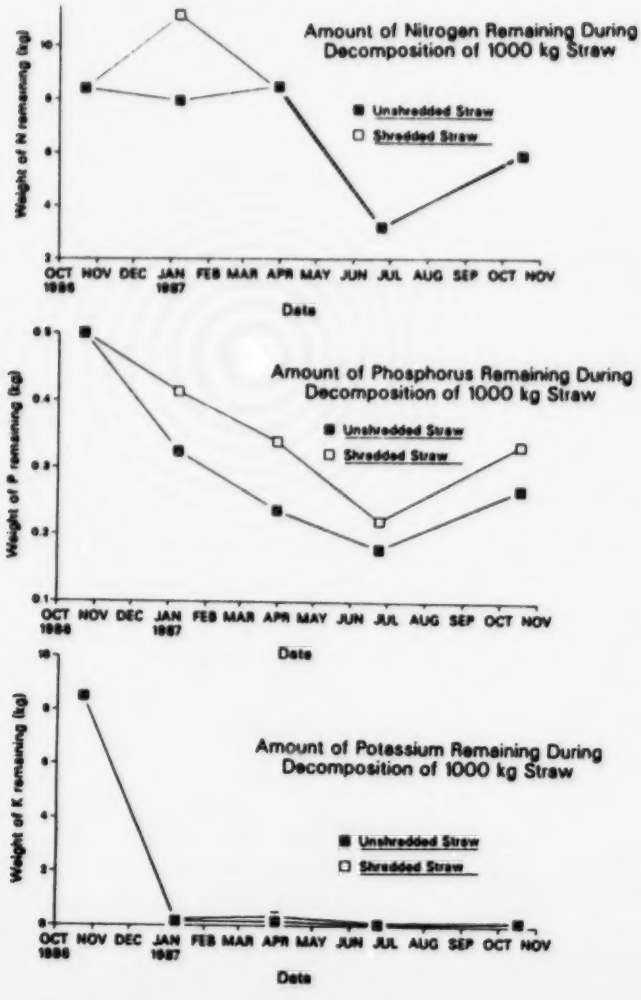


Fig. 11. The release of nitogen, phosphorus and potassium from shredded and unshredded straw over the period October 1986 to October 1987.

A Survey of Wild Rice Stands Across Northern Saskatchewan

Dr. O. W. Archibold - Department of Crop Science
University of Saskatchewan

This is now the fourth year in which productive wild rice stands across the province have been visited (Figure 1). The main objective when the project commenced was to determine if significant regional differences occurred in plant characteristics and stand productivity. Annual differences in potential production (assuming 100% pollination, 100% harvester efficiency and no losses through ducks, wind etc.) for the period 1984-1987 is shown in Figure 2. Potential production peaked in 1984, dropped considerably in 1985 and increased over 1986 and 1987. The characteristic production cycle reported in other provinces is clearly evident in this data. This fluctuation was previously offset in total Saskatchewan production data by annual increases in acreage.

In addition to the environmental factors and plant characteristics measured in previous years, panicle form, seed quality and sediment nutrient levels were also determined in the 1987 survey. Stand density ranged from 9.9 stems/m2 at Beaver River to 116 stems/m2 at Nemeiben Lake (Figure 3). Stands were generally densest in the central part of the province, but a good stand also developed at Keeley Lake. The number of seeds produced per stem increased towards the west part of the province (Figure 4). At Morning Lake and Nemeiben Lake only 19 seeds/stem were recorded compared to 74 seeds/stem at Churchill Lake. The increase in seed number is reflected in the degree of branching of the panicle (Figure 5). Seed heads also showed considerable variation in grain quality (Figure 6) with a high proportion of empty hulls and immature seeds noted at some sites. These characteristics have been used to estimate expected yields from the potential grain yields presented in past reports (Figure 7). Potential yield is calculated as stem density x seed weight x # seeds per stem whereas estimated yield takes into account the number of empty hulls. Expected yields ranged from 45 kg ha-1 at Deschambault Lake to 721 kg ha-1 at Mercer River. Again the reader is cautioned that these figures will not reflect actual harvest yields because of natural shattering and machinery efficiency.

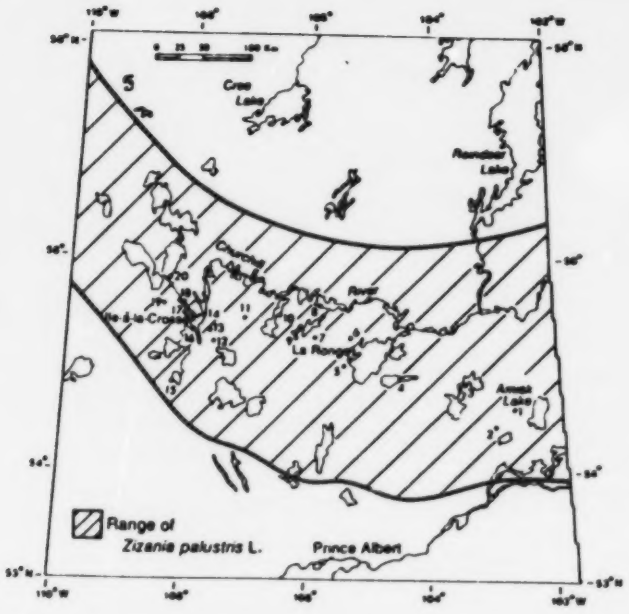


Fig. 1 Location of the 20 study sites.

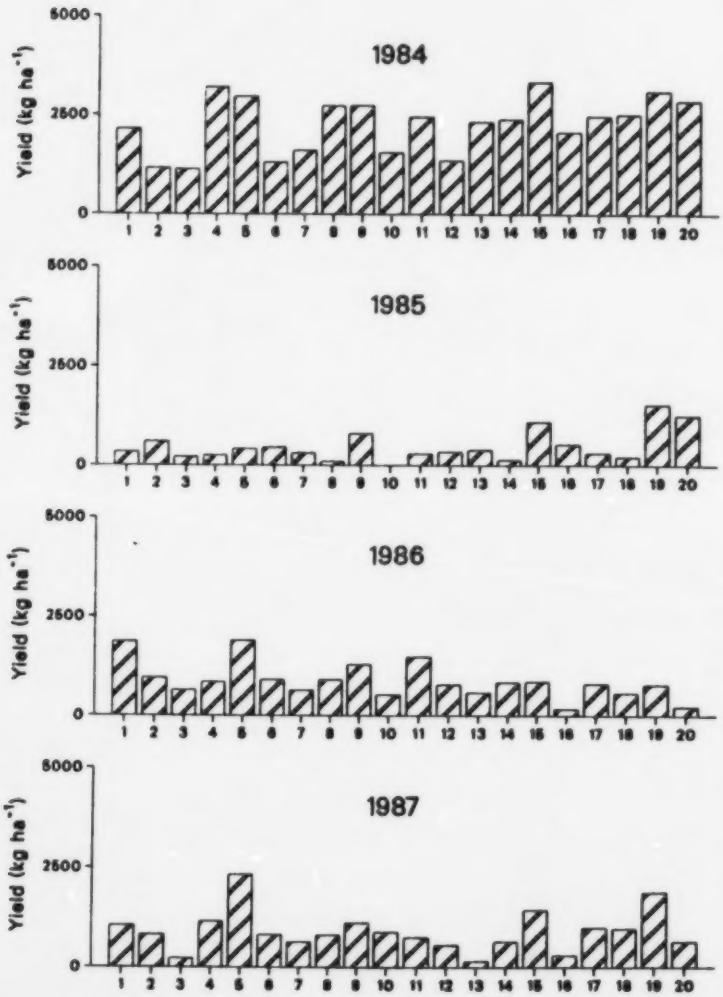


Fig. 2. Potential production for the period 1984-1987.

Germination tests were made on seed stored over winter in Demchenko Lake. Viability ranged from 23% to 81% (Figure 8). This could be an important consideration if growers are interested in keeping seed for new stand development. Samples of seed collected from the 20 sites were planted in growth tanks at the University of Saskatchewan. Under uniform growing conditions mean stem length showed less variation than in natural sites (Figure 9). The number of seeds produced per stem increased and differences between sites were less marked (Figure 10). One characteristic noted in earlier surveys was a tendency for sites in the eastern part of the province to mature earlier. Data from the growth tank trials substantiates this (Figure 11) indicating that some genetic differentiation has occured in the population.

Environmental conditions are shown in Figure 12. Water depth ranged from 50 cm at Lac Ile a la Crosse to 148 cm at Morning Lake. In general water depths decreased towards the west. Water temperature at the time of the survey ranged from 15 to 21oC with the west side being somewhat cooler. Apart from Nemeiben Lake which recorded acid water conditions (pH 6.1) all other sites were slightly alkaline with the highest pH values recorded at Wapawekka Lake and Kazan Lake. Water conductivity was the most variable parameter ranging from below 50 mS cm-2 at Nemeiben and Morning lakes to over 250 mS cm-2 at Keeley Lake. Sediment nitrogen, phosphorus and potassium levels is shown in Figure 13. Nitrogen levels tended to be lowest in the central districts. High phosphorus levels were noted at Lac Ile a la Crosse, Aubichon Arm and Churchill Lake but elsewhere phosphorus concentrations were typically below 10 ppm. Sediment potassium levels were generally highest in the western districts. Potential yield shows a slight increase with increasing nitrogen and potassium levels (Figure 14).

Summary

1. Significant regional differences exist in the wild rice population for morphological characteristics such as tillering capacity, stem length, and number of seeds per head. The plants in the western sites tend to be more robust.

2. Plants typically develop earlier in the east side of the province and may be ready for harvest 7 to 10 days earlier than elsewhere.

3. Water depth is the main factor which determines the height of the plants and their performance. Other environmental parameters such as water pH and conductivity also affect plant size.

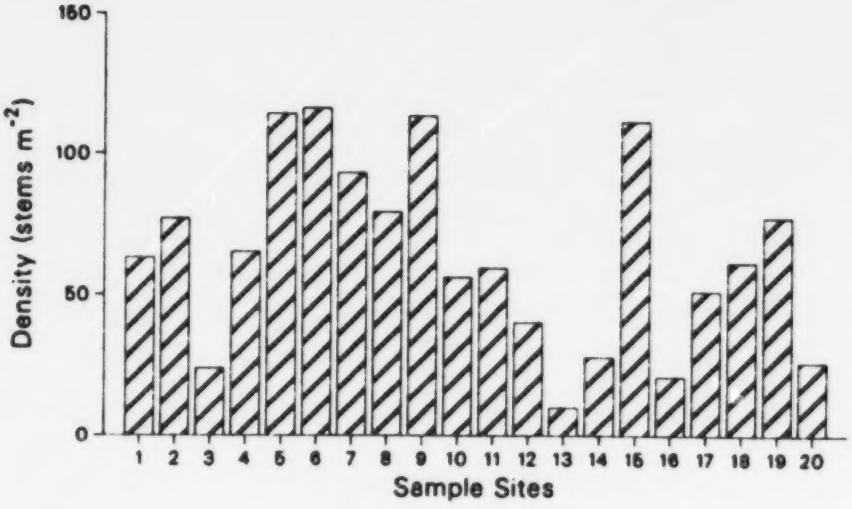


Fig. 3. Mean stand density at the 20 sites.

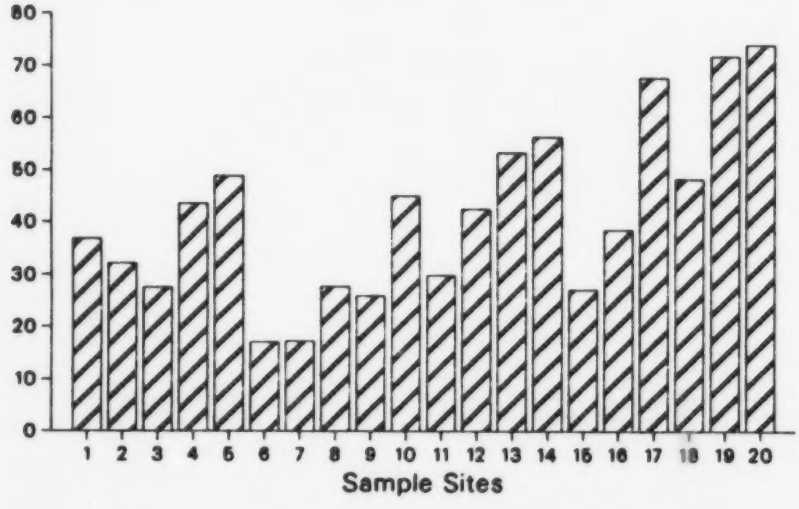


Fig. 4. Average seed production per stem.

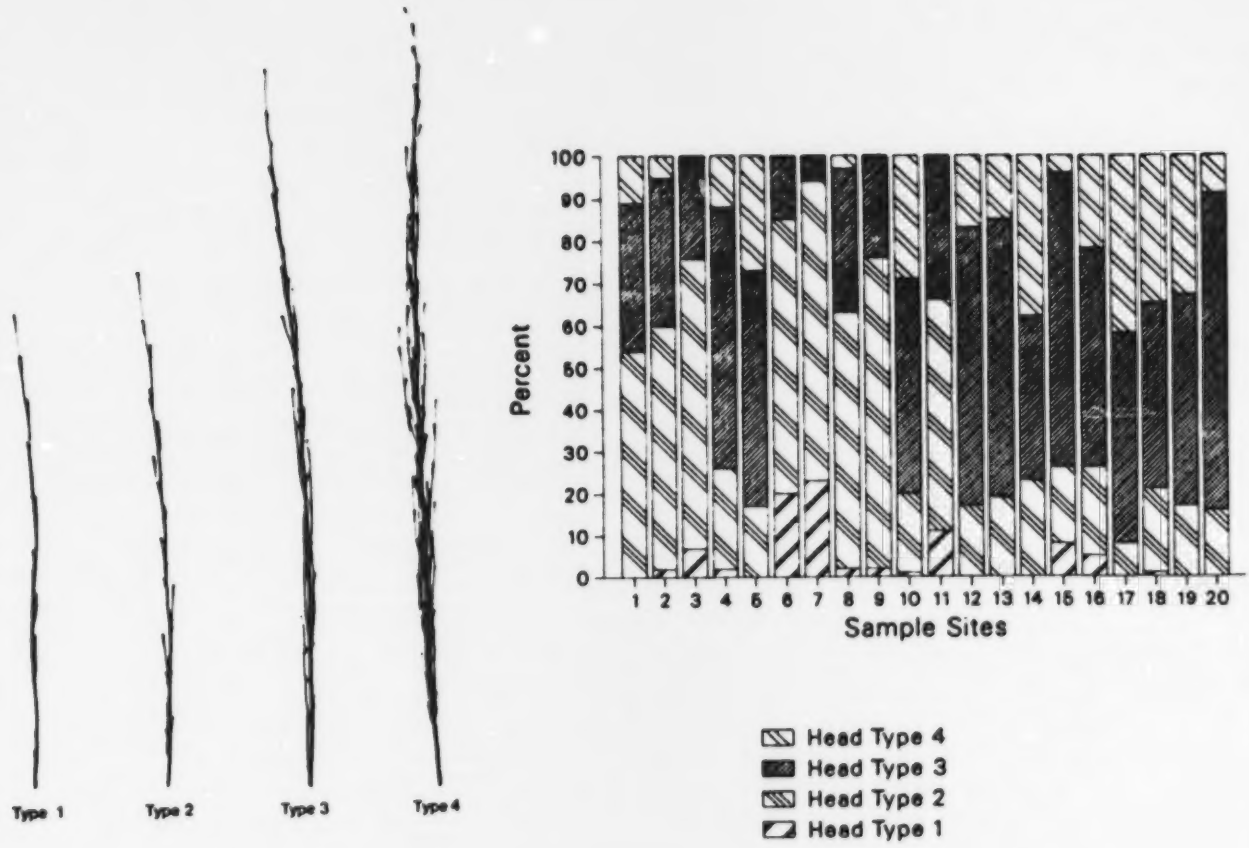


Fig. 5. Branching characteristics of the flower heads.

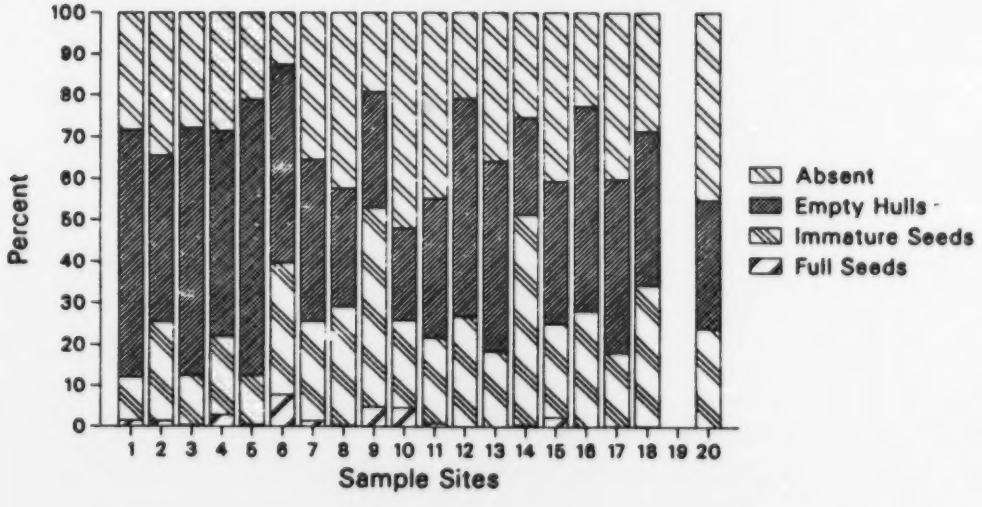


Fig. 6. Seed quality at the 20 sites.

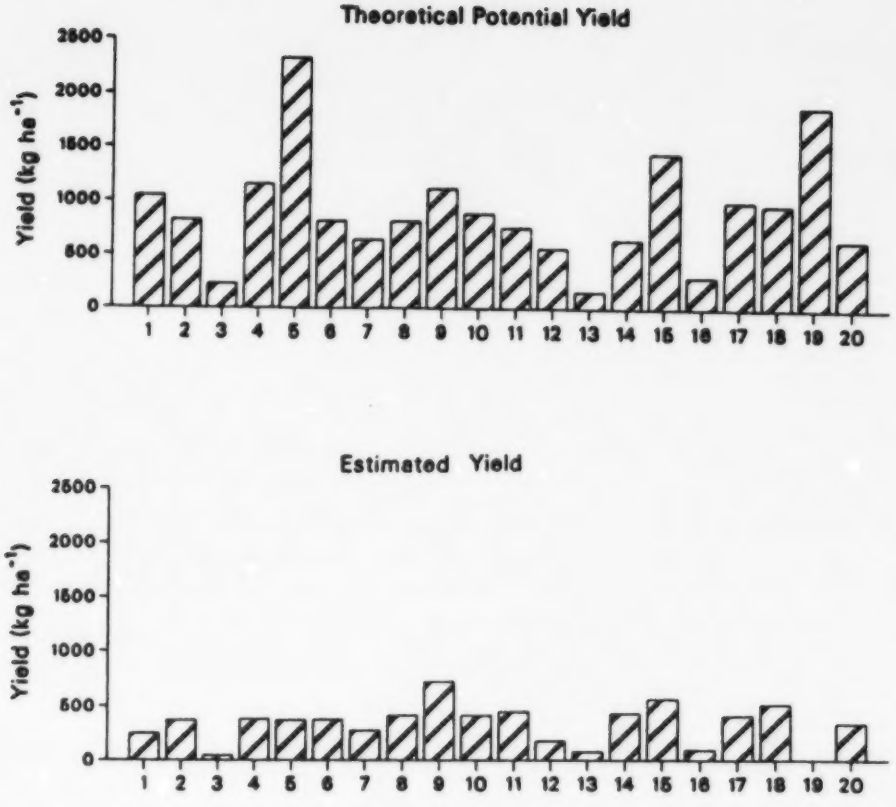


Fig. 7. Theoretical potential yield (upper) and estimated yield (lower) which takes into account the number of empty hulls.

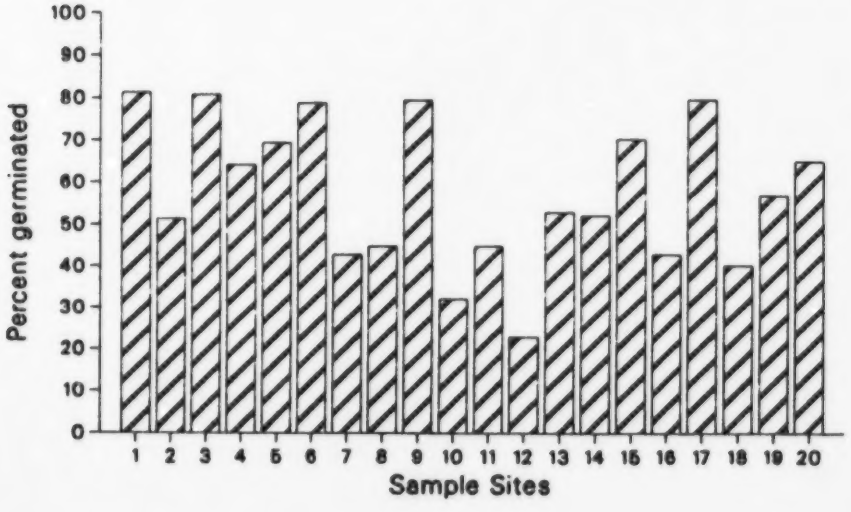


Fig. 8. Germination quality of overwintered seed.

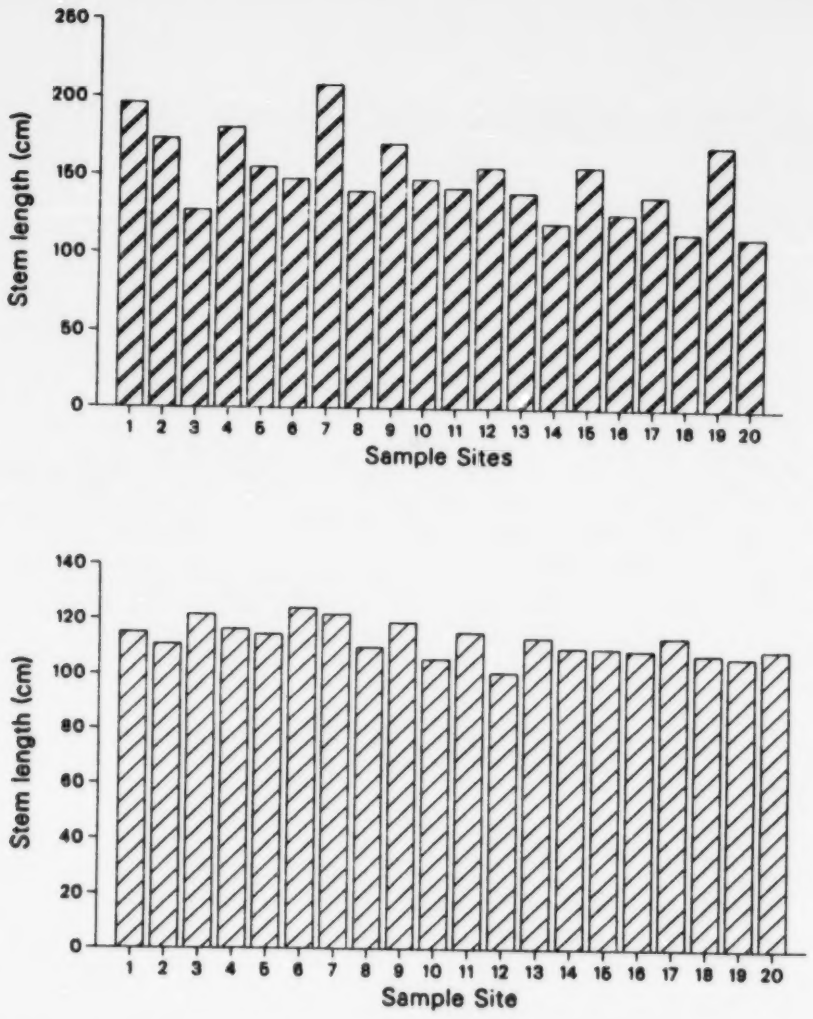


Fig. 9. A comparison of mean stem length of plants growing in the study lakes (upper) and those growing under uniform conditions in growth tanks.

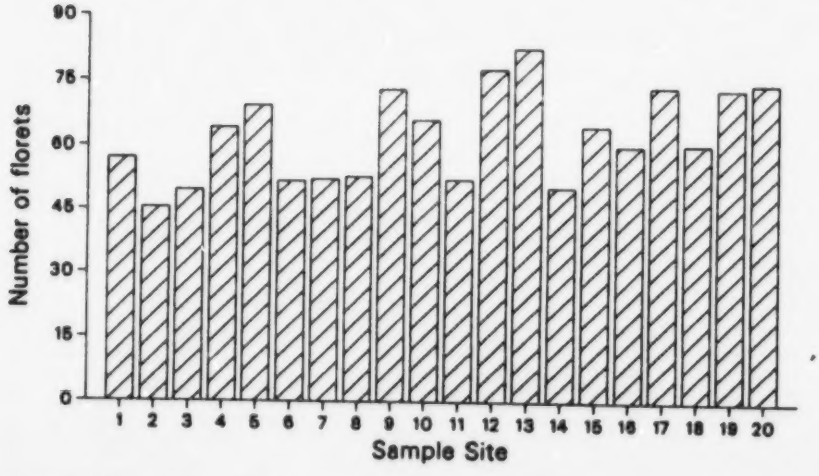


Fig. 10. The number of seeds per stem produced by plants growing under uniform conditions (compare to Fig. 4 for lake grown plants).

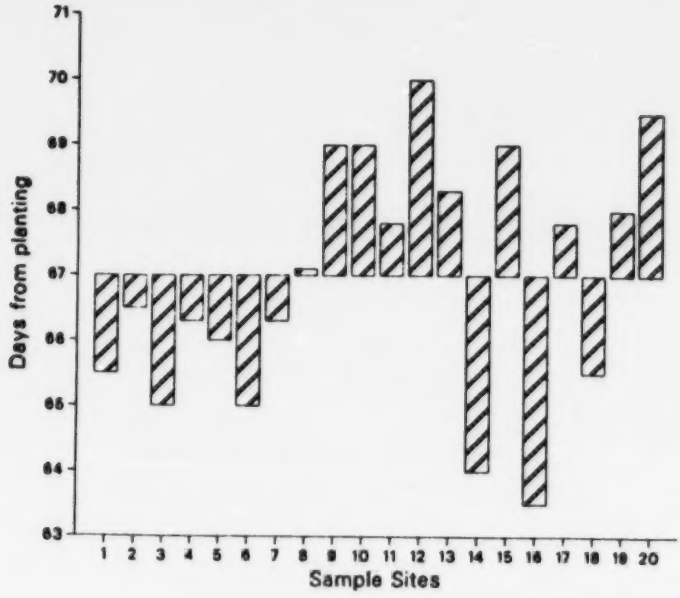


Fig. 11. Number of days from planting for 80% flowering for plants grown under uniform conditions.

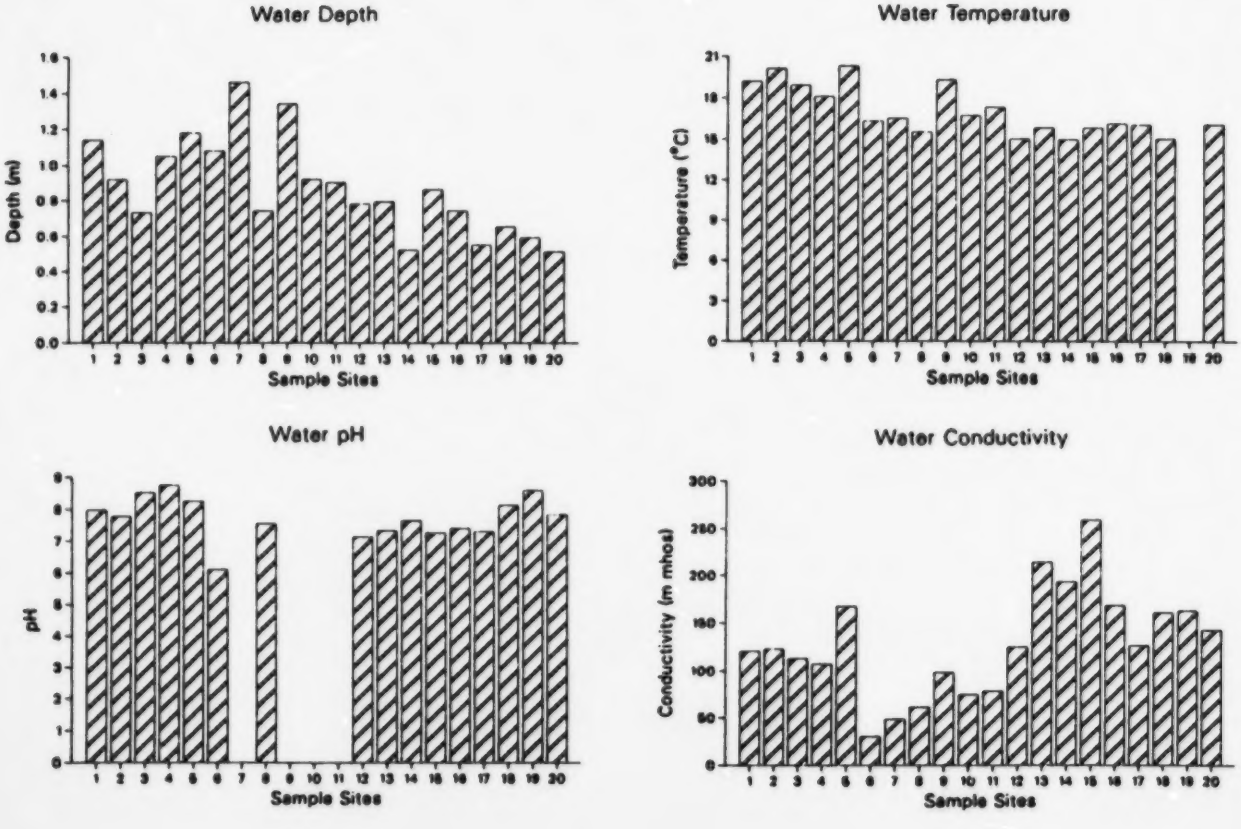


Fig. 12. Environmental conditions at harvest time 1987.

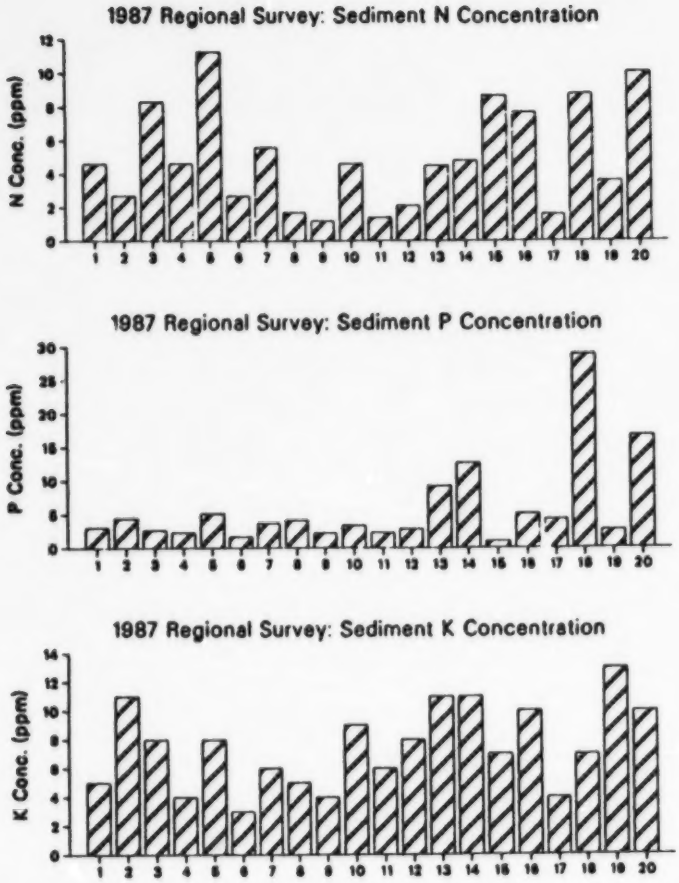

1987 Regional Survey: Sediment N Concentration
N Conc. (ppm)
1987 Regional Survey: Sediment P Concentration
P Conc. (ppm)
1987 Regional Survey: Sediment K Concentration
K Conc. (ppm)

Fig. 13. Sediment nitrogen, phosphorus and potassium levels at the 20 sites.

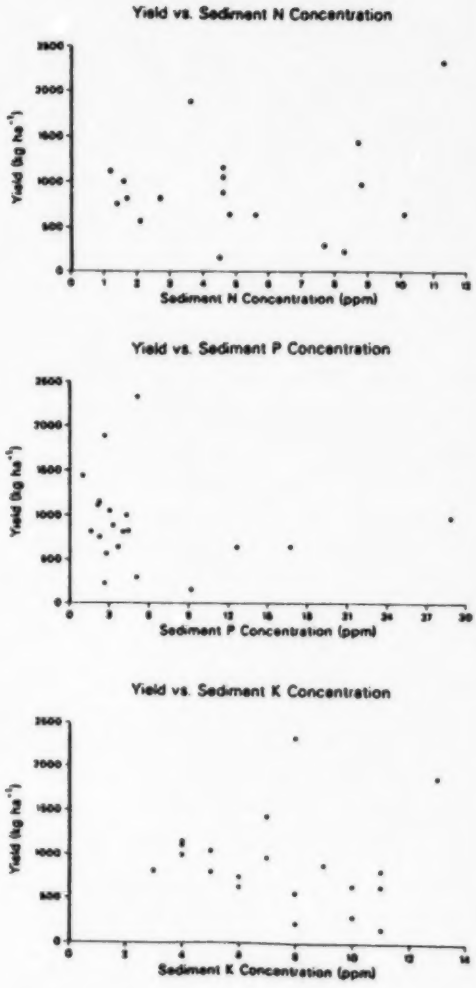

Yield vs. Sediment N Concentration
Sediment N Concentration (ppm)
Yield vs. Sediment P Concentration
Sediment P Concentration (ppm)
Yield vs. Sediment K Concentration
Sediment K Concentration (ppm)

Fig. 14. The relationship between sediment nitrogen, phosphorus and potassium levels and 1987 potential yields.

4. Although the length of the growing season as determined both by the frost free period and number of growing degree days is not related to regional differences in plant performance, productivity does show a significant decrease in the western sites.

5. Because of expanding acreage, total provincial production has tended to steadily increase. However, the four-year production cycle characteristic of other provinces has been noted at the sites selected for this study.

6. Significant differences are seen in seed head characteristics of the plants. Multi-branched flower heads are most common in the west.

7. Failure of grain to develop in some hulls was common across the province. A high percentage of immature kernels was also noted.

8. Cycles in grain production are reflected by straw production. A steady build-up in straw is now occurring.

9. Plants grown at the University of Saskatchewan from seed collected from the 20 sites showed little of the variation seen in the field. This suggests that many of the characteristics of the population simply reflect environmental variation. However, the tendency for earlier development characteristic of the eastern sites was maintained in the university grown plants. This suggests that some selection has occurred within the natural population.